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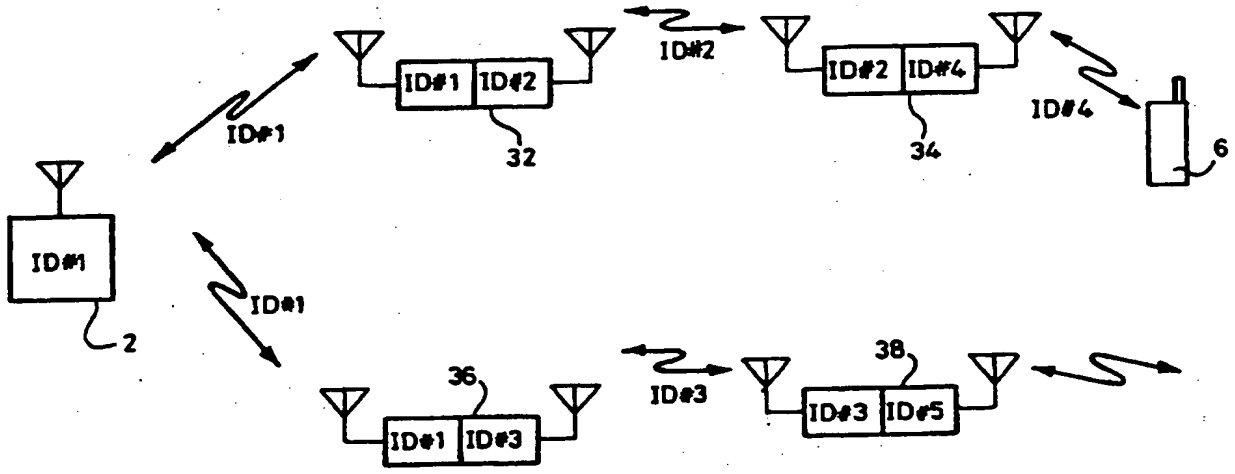

(57) Abstract

A radio communications system such as a TDMA system, in which the or each base station (2) has a unique identity code and the or each repeater (32, 36) has a different unique identity code also different from that of any other repeater, and the or each repeater, when re-transmitting a signal received from the base station or another repeater, replaces the contained identity code with its own identity code, a portable receiver (6) receiving the signal storing the contained identity code and using it to access the repeater having that unique code.

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RADIO COMMUNICATIONS SYSTEMS WITH REPEATERS USING IDENTIFICATION CODES

This invention relates to radio communications systems, especially TDMA systems, having one or more base stations able to communicate with portable stations via repeaters.

In radio communications systems generally, it is often desired to increase the communication range of a base station. In some circumstances it is appropriate to accomplish this by the use of repeaters.

There exist a variety of known kinds of repeaters which, apart from use to increase the range of point to multi-point digital radio systems, are also often used to "fill-in" holes in coverage, e.g. resulting from deep valleys or tunnels.

In TDMA radio systems, repeaters receive information in one time slot and retransmit it in another time slot. This technique is appropriate in situations in which there is only one repeater or the repeaters are isolated from each other and are thus unable to transmit information from one repeater to another.

The technique thereby cannot readily be made useful when applied to networks of overlapping coverage, especially for example as is commonly the case in cordless telephone systems.

A principal object of the present invention is to maximise the coverage area of a base station, e.g. by surrounding the base station with a substantial plurality of radio

repeaters. The problem to be overcome is that of repeaters re-transmitting the transmissions made by other repeaters as well as the transmission by the base station, which could lead to exponential traffic congestion.

Complex system planning could operate to prevent multiple mutual re-transmissions, but this is not a satisfactory practical option. The present invention provides a better solution to the problem, especially in the case of networks of randomly positioned TDMA communications portable stations used with repeaters of overlapping coverage.

According to the invention there is provided a radio communications system comprising at least one base station and one or more radio repeaters, wherein the base station has an allotted unique identity code and each repeater has an allotted unique identity code different from that of the base station and of any other repeater, and the one or more repeaters are adapted to re-transmit only transmissions originating with a single specified identity code and when re-transmitting replace at least part of the specified code with the identity code unique to that repeater.

Most preferably, the or each repeater is also adapted to accept from portable stations (handsets) only transmissions addressed with the identity code of that repeater and replace at least part of the code with a further preprogrammed code, typically the code of the base station or that of another repeater in the re-transmitted signal.

The invention is especially applicable to TDMA radio communications systems in which time-division multiplexed signals are transmitted.

The invention is now further described with reference to the accompanying drawings, in which:-

Figure 1 shows a typical configuration of conventional wireless TDMA repeater network;

Figure 2(a) shows a single repeater for extending the range of a base station;

Figure 2(b) shows a multiplicity of repeaters for extending the range of a base station;

Figure 2(c) shows the overlapping coverages of the repeaters 2(b) which will commonly exist in practice;

Figure 3 shows typical transmit and receive timings of the base station, a repeater and a portable station; and

Figure 4 shows a base station and a multiplicity of wireless repeaters in an exemplary arrangement in accordance with the invention.

Referring to Figures 1 and 3, during the operation of a conventional base station 2, it transmits a time-division multiplexed radio carrier 48. During each different time slot a different portable unit 6 communicates with the base station 2. Normally, the maximum distance that the portable unit may be from the

base station is governed by the transmitter power, the receiver sensitivity and the propagation environment. However, the range of the single base station is extended by using known wireless repeater techniques. Referring to Figure 1, the repeater 10 is located within range of the base station 2 and re-transmits (signal 48A) the signal 18 from the base station so that it is receivable by the handset 6.

Thus, referring to Figure 3, the repeater receives transmissions from the base station in one time slot 56 and re-transmits the identical information in another time slot 58. The portable station receives this information in time slot 60 and transmits a response in time slot 62, received by the repeater in time slot 64. The repeater re-transmits this signal in time slot 66 and the signal is received by the base station in time slot 68. Figure 3 shows the timings for a time division duplex station such as DECT; the same principle applies to frequency division TDMA systems such as PACS. References 70 to 80 denote repeat code transmissions in the second pair of time divisions 50, 52.

This known technique is satisfactory when there is only one repeater, as in Figure 2(a), or if there are several repeaters which are unable to receive transmissions from each other. However, if there is an arrangement such as that shown in Figure 2(b) where there is a single base station surrounded by a number of repeaters then major problems arise. One of the major problems is that the repeaters re-transmit each other's transmissions as well as the base station's transmissions. This is an extremely serious and limiting problem since it leads to an unstable and potentially exponential increase in unnecessary

transmissions. It is very difficult if not impossible to find locations for the repeaters 8, 10, 12, 14, 16, 18 of Figure 2(b) where each can communicate with the base station but not receive transmissions from other repeaters. Figure 2(c) shows the overlapping coverage of areas 20, 22, 24, 26, 28, 30 of the repeaters shown in Figure 2(b) as might typically exist in practice.

Another problem is that when a portable station 6 makes a call attempt, the call attempt may be picked up by one of the repeaters at random rather than by the closest repeater. Another problem is that if the repeater repeats every transmission that it receives, it will repeat transmissions from base stations belonging to different organisations.

In TDMA digital radio systems such as DECT or PACS, cordless telephone portable handsets make calls via a base station. A system may comprise more than one base station with each base station connected to a common controller.

Conventionally, each base station has an allotted identity code. This identity code comprises two parts, a part which is common to all base stations in the system and a part which is unique (within a particular geographic area). The "system identity" part which is common to all the base stations in the system is used to identify the system so as to allow properly authorised portable units to make calls via that system. The "base identity" part which is unique to each base station (or unique within a limited geographical area) is used to allow portable units to measure received signal strength and directly to address a particular base-station. In

DECT system arrangements the "system identity" is termed the "Access Rights Indicator" or ARI and the "base station identity" is termed the "Radio Fixed Part Number" or RPN. PACS system arrangements use a similar scheme to identify access rights and "Port IDs".

The identity (or parts of the identity) is transmitted from the base station at various times. It is also exchanged between the base station and the portable station at various times to confirm that an unauthorised handset has not by accident or fraudulently become attached to the base station.

However, in conventional wireless repeater systems, the or each repeater re-transmits exactly what it receives.

According to the invention each of the repeaters is allocated an identity code different from that of the base station code and from the code of each other repeater. Each repeater is configured to repeat transmissions originating from a single, specified base station identified by its code. The repeater analyses each of the transmissions for the occurrence of this specified base station identity code. Before re-transmitting the signal it replaces the base station identity code with its own identity code. For example, referring to Figure 4, the base station 2 has base station identity code ID#1. Two repeaters 32, 36 are configured to repeat transmissions originating from this base station. Repeater 32 is configured to replace ID#1 with ID#2 before re-transmitting. Repeater 36 is configured to replace ID#1 with ID#3 before re-transmitting. A further pair of repeaters 34, 38 is also used to extend the range even further. Repeater 38 is configured to repeat transmissions originating with

code ID#3 and to replace this code with the code ID#5. Repeater 34 is configured to repeat transmissions originating with code ID#2 and to replace this with code ID#4. The portable unit 6 is closest to repeater 34 transmitting with code ID#4. The portable unit 6 stores this code, i.e. code ID#4.

To make a call, the portable unit 6 directly addresses repeater 34 by sending an access message containing code ID#4. This repeater 34 then changes code ID#4 to code ID#2 and re-transmits. Repeater 32 then receives this transmission, replaces code ID#2 with code ID#1 and re-transmits. The base station 2 then receives the transmission.

In DECT systems the specified unique codes replace the Radio Part Number (RPN), which is transmitted at various times and locations within the medium access layer signalling. However, the repeater changes the code on each and every occurrence of the identity, originally the RPN identity, in all such situations.

Claims

1. A radio communications system comprising at least one base station and one or more radio repeaters, wherein the base station has an allotted unique identity code and each repeater has an allotted unique identity code different from that of the base station and of any other repeater, and the one or more repeaters are adapted to re-transmit only transmissions originating with a single specified identity code and when re-transmitting replace at least part of the specified code with the identity code unique to that repeater.

2. A radio communications system according to claim 1, wherein the or each repeater is also adapted to accept from portable stations (handsets) only transmissions addressed with the identity code of that repeater and replace at least part of the code with a further preprogrammed code.

3. A radio communications system according to claim 2, in which the repeater replaces at least part of the code of an accepted transmission from a portable handset with the code of a base station or another repeater.

4. A radio communications system according to any of claims 1 to 3, having a plurality of base stations and a plurality of repeaters each with a unique identity code, and each repeater is configured to repeat only transmissions received from one particular base station identified by its code.

5. A radio communications system according to any of claims 1 to 4, in which the specified identity codes are additional to a system identity code incorporated in the transmissions.

6. A radio communications system according to any of claims 1 to 5, in which a portable receiver (handset) receiving a transmission stores the identity code incorporated in the transmission and, when transmitting an access message to open communication, includes the stored identity code in the access message.

7. A radio communications system according to any of claims 1 to 6, in which the part of the transmission by each repeater containing its specified unique code is used by a portable receiver to measure received signal strength.

8. A radio communications system according to any of claims 1 to 7, in which the specified unique codes of each repeater are transmitted in the same time slots as those normally used for re-transmission of the base station identity code.

9. A radio communication system according to any of claims 1 to 8, applied to a TDMA radio communications system in which time-division multiplexed signals are transmitted.

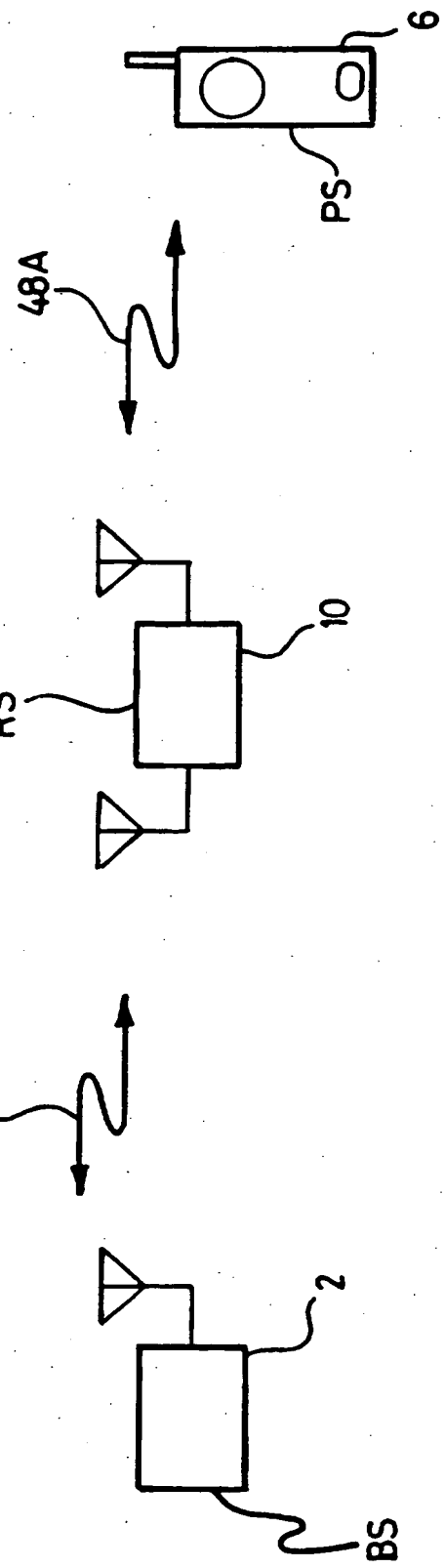


Fig. 1

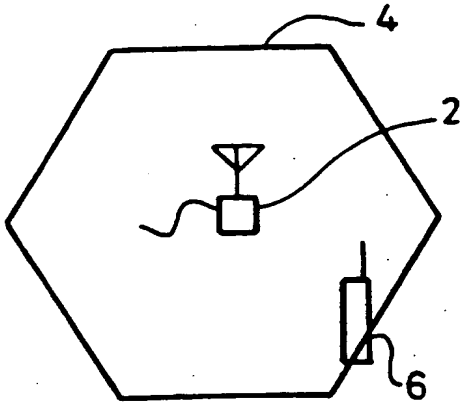


Fig. 2a

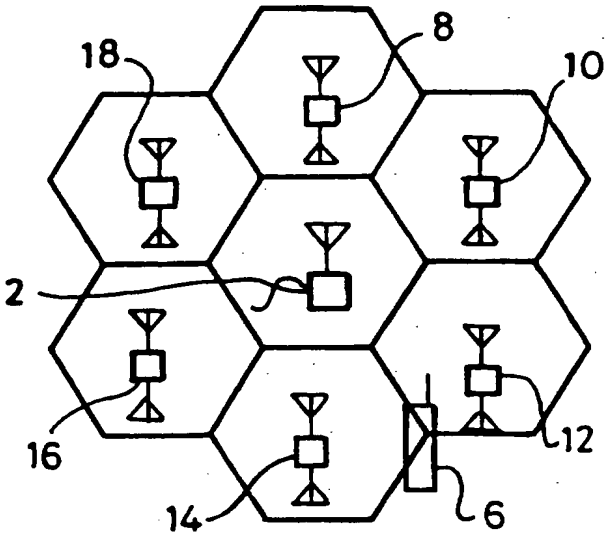


Fig. 2b

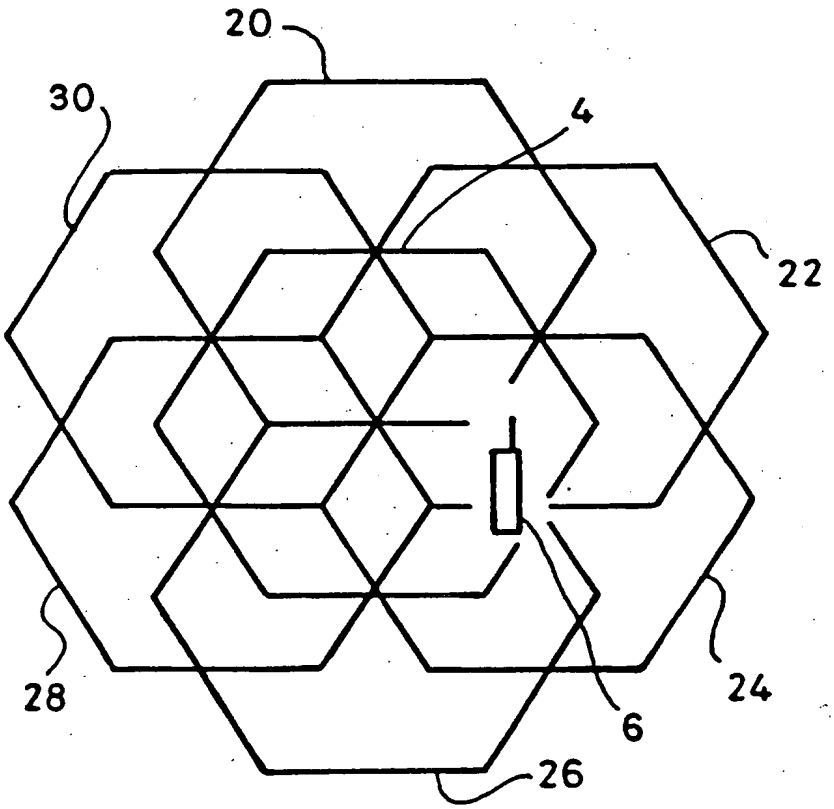
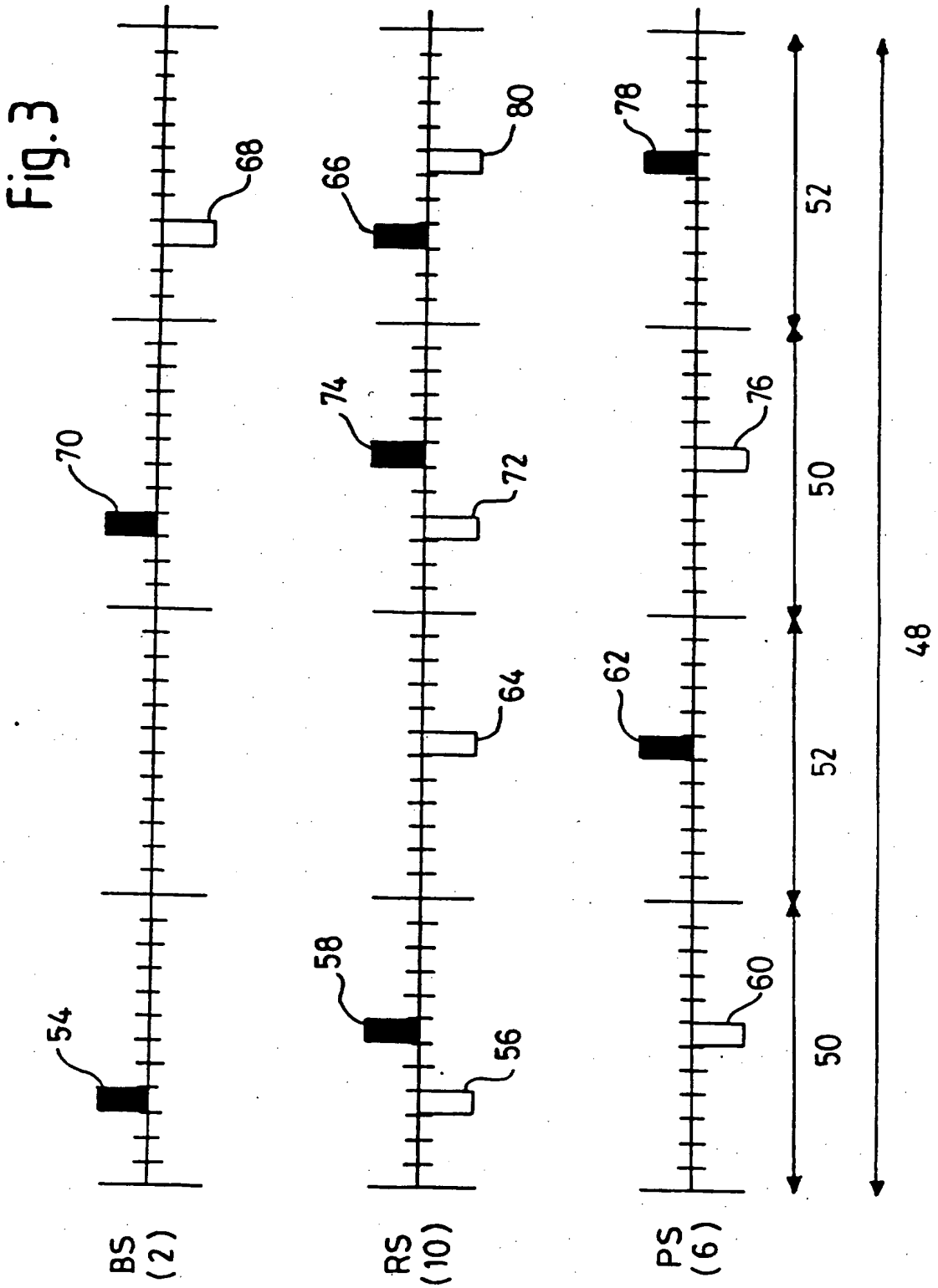


Fig. 2c

Fig.3



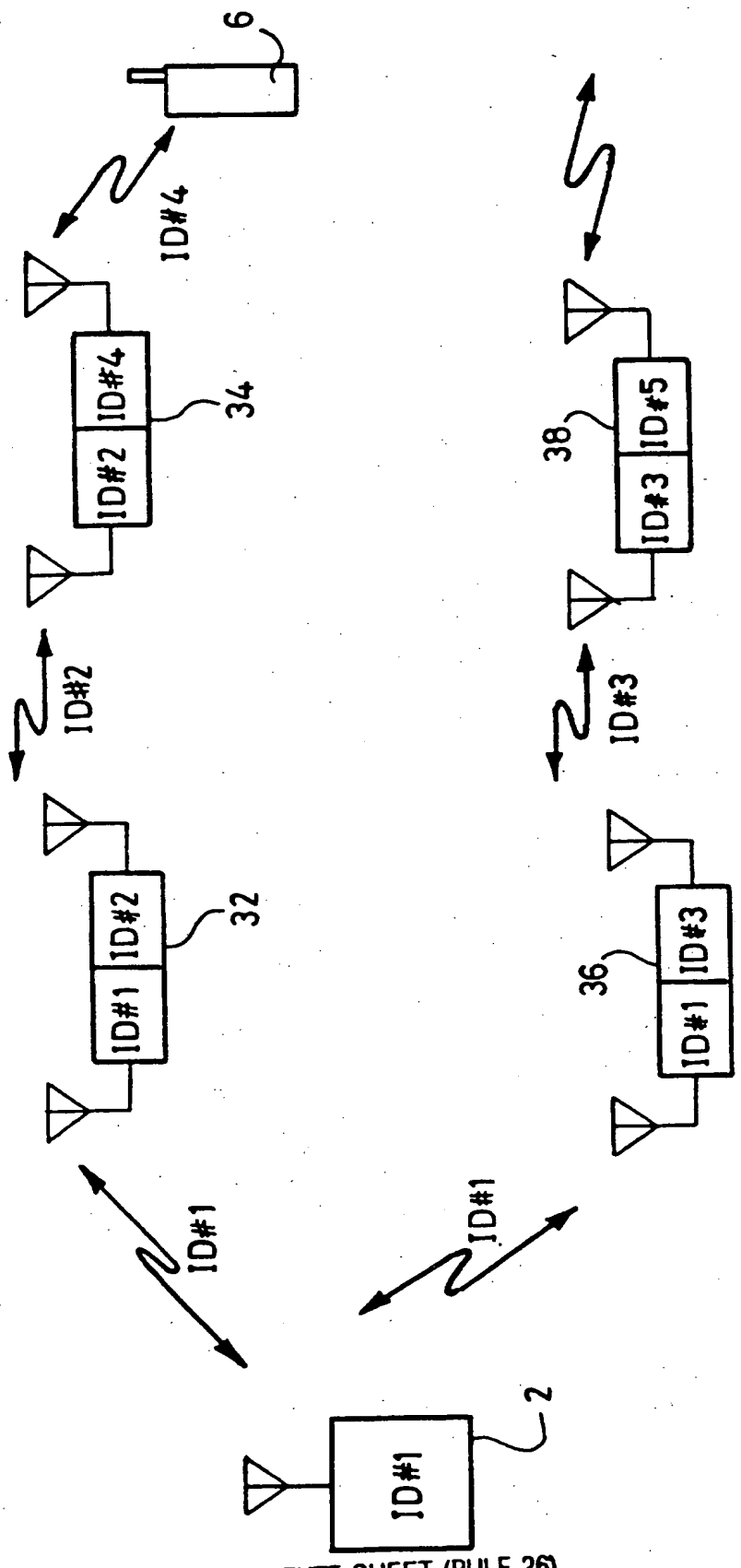


Fig. 4

INTERNATIONAL SEARCH REPORT

Internal Application No
PCT/GB 96/00078

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04B7/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04B H04Q

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	WO,A,95 12956 (NOKIA TELECOMMUNICATIONS OY) 11 May 1995 see claims 1-9; figures 1-3	1-9
X	PATENT ABSTRACTS OF JAPAN vol. 017, no. 015 (E-1305), 12 January 1993 & JP,A,04 245819 (PIONEER ELECTRON CORP), 2 September 1992, see abstract	1
X	PATENT ABSTRACTS OF JAPAN vol. 014, no. 218 (E-0925), 9 May 1990 & JP,A,02 052532 (KANDA TSUSHIN KOGYO CO LTD.), 22 February 1990, see abstract	1

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X	PATENT ABSTRACTS OF JAPAN vol. 013, no. 301 (E-785), 11 July 1989 & JP,A,01 078042 (FUJITSU LTD), 23 March 1989, see abstract	1
X	PATENT ABSTRACTS OF JAPAN vol. 012, no. 268 (E-638), 27 July 1988 & JP,A,63 051727 (NEC CORP.), 4 March 1988, see abstract	1
A	EP,A,0 526 388 (CITY COMMUNICATIONS LIMITED) 3 February 1993 see claims 1-11	1
A	US,A,4 230 989 (BUEHRLE) 28 October 1980 see column 2, line 5 - line 68; figure 1	1

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WO-A-9512956	11-05-95	FI-A- 934826	02-05-95
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EP-A-526388	03-02-93	US-A- 5369784	29-11-94
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